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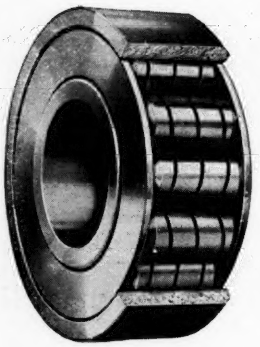

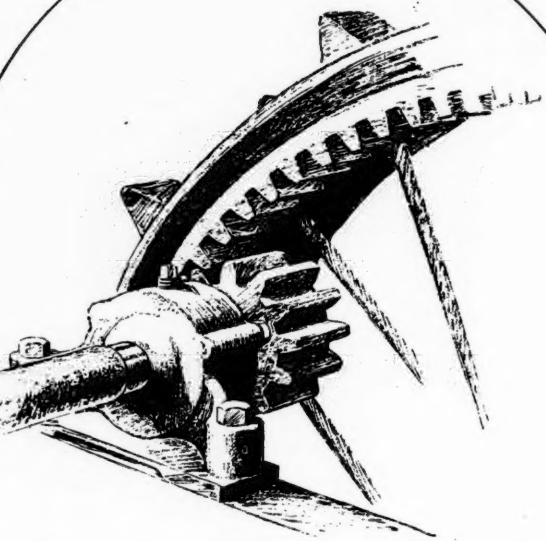

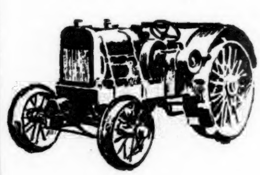

AGRICULTURAL ENGINEERING

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Comparison of Cost of Tile Drainage and Value of Improved Farm Lands in Minnesota*

By **H. B. Roe**

Mem. A.S.A.E. Chief, Section of Drainage, Division of Agricultural Engineering, University of Minnesota

THE tile drainage records of the Minnesota State Agricultural Experiment Station extend over a period of fifteen years from 1907 to 1922 inclusive. From the mass of records accumulated during this period there have been selected as a basis for this discussion fifteen farm drainage projects planned and installed under the close personal supervision of members of the station drainage staff. The discussion is limited to these fifteen because they are the only ones for which practically complete cost data are available and which, at the same time, are reasonably free from influential conditions that depart to an abnormal degree from the average. The accompanying table shows a number of details pertinent to the subject relating to each of these projects. This table should be kept in view throughout the reading of this paper.

SCOPE OF THE PROJECTS

General Data

Number of different farms	19
Number of different owners	18
Number of counties represented.	
1. In Minnesota	
Northeast portion	2
Northwest portion	1
Central portion	2
Southeast portion	5
	10
2. In eastern North Dakota	2
Grand total	12

Installation Months. May to November inclusive, hence digging was not seriously affected by frost.

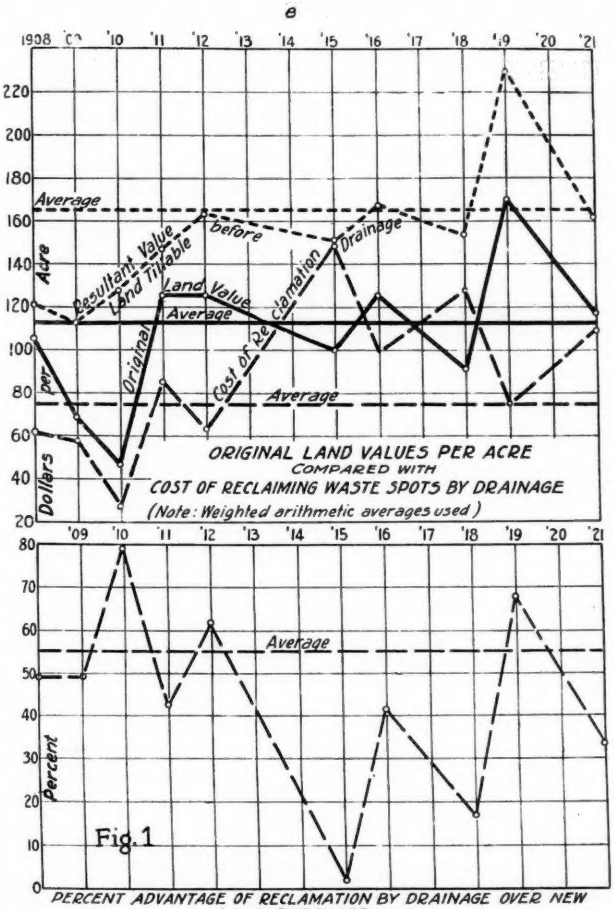
Surface Types.

In mineral soil	1. Rolling	
	(a) Heavily rolling	1
	(b) Rolling	4
	(c) Gently rolling	1
	Total	6
	2. Flat	
	(a) Mixed	1
	(b) Flat	6
	Total	7
In peat soil		2
Total		15

*Journal Series Paper No. 381, Department of Agriculture, University of Minnesota.

Soil Types and Digging Conditions. There were ten major soil types or combinations of such represented, as follows:

1. Clayey lake bed (Items 9 and 10); digging mostly average but very sticky after rains.
2. Clayey lake bed—extra tight—near gumbo (Items 2 and 8); digging tolerably easy but wet and sticky.
3. Clayey lake bed interspersed with peaty swamp pockets (Item 15); sandy enough to make digging easy; dry.



PERCENT ADVANTAGE OF RECLAMATION BY DRAINAGE OVER NEW LAND PURCHASE

Comparison of Cost of Reclamation by Drainage with Value of Land for Farming Purposes, Based on Producing Power.

Item Number	Number of Owners	Designation of Owners	Town	County	Date of drainage Installation		Classification of Land						Area in Acres		Percent of Watershed on Farm Reclaimed	Estimated Value in Dollars per Acre		Total cost of drainage in dollars	Cost of drainage in Dollars		Advantage of Cost of drainage over New land purchase: Based on Entire Area of Watershed on Farm		Based on area tillable before drainage	
					Month	Year	Heavily Rolling	Rolling	Gently Rolling	Mixed	Flat	Peat	Watershed within boundary of farm drained	Reclaimed		for total Watershed on farm	Resultant—for area tillable without drainage		Per Acre of Watershed on Farm	Per acre reclaimed	Dollars per acre	Per cent	Dollars per acre	per cent
1	1	a	Zumbra Heights	Carver	Aug.-Nov.	1908			✓				72.89	10	13.72	105	121.71	615.00	8.44	61.50	43.50	41.43	60.21	49.47
2	1	b	Opposite Halstad, Minn.	Traill Co., N. Dak.	May-Jun.	1909					✓		160.00	80	50.00	65	130.00	4647.08	29.20	58.09	6.91	10.63	71.91	55.32
3	1	c	Belle Plaine Scott Co.	Carver	Sept.-Oct.	1909		✓					76.00	14	18.42	75	91.94	758.02	9.97	54.14	20.86	27.81	37.80	41.11
4	1	a	Grand Rapids	Itasca	July-Sept.	1910				✓			185.00	100	54.05	50	108.82	3710.94	20.06	37.11	12.89	25.78	71.71	65.89
5	1	d	Oakland	Freeborn	Oct-Nov.	1910					✓		120.00	95	79.17	40	192.00	1544.77	12.87	16.26	23.74	59.35	175.74	91.53
6	1	e	Osakis	Douglas	May-Jun.	1911		✓					120.00	8	0.67	125	133.93	1288.30	10.74	161.04	-36.04	-28.83	-27.11	-20.24
7	1	f	Faribault	Rice	July-Nov.	1911		✓					~~237.00~~	~~56~~	~~23.63~~	~~125~~	~~163.67~~	~~3529.27~~	~~14.89~~	~~63.02~~	~~61.98~~	~~49.54~~	~~100.65~~	~~61.50~~
					June-Aug.	1912																		
8	1	g	Fargo	Cass Co. N. Dak.	June-Aug.	1915					✓		95.00	32*	33.68	100	150.79	4740.67	49.90	148.15	-48.15	-48.15	2.64	1.75
9	1	h	Moorhead	Clay	Sept.-Nov.	1916					✓		300.00	76*	25.33	125	167.41	7483.74	24.95	98.47	26.53	21.22	68.94	41.18
10	1	k	Glyndon	Clay	May-Nov.	1918					✓		255.00	75	29.41	100	141.67	10168.93	39.88	135.59	-35.59	-35.59	6.08	4.29
11	1	m	Coon Creek	Anoka	Aug.-Oct.	1918																		
					Apr.-May	1919						✓	40.00	28	70.00	20	66.67	2932.00	73.30	104.71	-84.71	-423.55	-38.04	-57.06
					Nov.-Dec.	1921																		
					May-June	1922																		
12	6	n, o, nc	New Market	Scott	July-Sept.	1919	✓						500.00	120	24.00	175	230.26	9065.27	18.13	75.54	99.46	56.83	154.72	67.19
13	1	a	Fens	St. Louis	May-June	1919						✓	20.00	15	75.00	50	200.00	1038.13	51.91	69.21	-19.21	-38.42	130.79	65.40
14	1	p	Paynesville	Stearns	Jun.-Sept.	1921		✓					138.84	35	25.21	125	167.13	3749.50	27.01	107.13	17.87	14.30	60.00	35.90
15	1	s	Meadowlands	St. Louis	Oct.-Nov.	1921					✓		7.00	2.50	35.71	50	77.78	277.92	39.70	111.17	-61.17	-122.34	-33.39	-42.93
15	18		Totals	12			1	4	1	1	6	2	2326.73	746.50				55549.59						
Weighted arithmetic average															32.08	112.58	165.76		23.87	74.41	38.17	33.90	91.35	55.11

4. Black muck (2 feet) over lake bed clay (Item 5); digging fair with some sticky gumbo pockets.
5. Boulder clay and stony ground moraines (Item 6); digging very hard, largely pick work.
6. Boulder clay with thin peat blanket, 6 to 30 inches deep (Item 14); digging good when dry, but very sticky after rains.
7. Clayey moraines thickly interspersed with common marsh and shallow peat pockets (Items 1 and 12); digging mostly good on ridges but hampered by permanent water in marsh and peat pockets; occasional thin hardpan layers encountered.
8. Overridden moraines interspersed with marsh pockets; some clear sandy loam, some deep peat, and some very stony clay (Item 4); digging widely varied; considerable interference from caving due to seepage.
9. Deep peat filled with tamarack roots and stumps which greatly hindered the otherwise easy digging (Item 13).
10. Peat 4 to 6 feet deep underlaid to an indefinite depth with windblown sand (Item 11); digging mostly very easy except where the heavy seepage from the sand hills caused caving and running in of thin mud.

Tile Shipment Conditions. Lengths of rail shipment varied from less than 50 miles up to about 500 miles so that the influence of freight charges on total cost is a widely varying factor.

Methods of Construction. In most cases the digging was done by hand under the supervision of an experienced foreman, but there were the following exceptions: (1) Under Items 1 and 5 there was considerable top digging by a horse-drawn machine (the Bennett); (2) under Items 11 and 12 the digging was done almost exclusively by a heavy power machine (the Buckeye); and (3) Item 14 was a contract job with numerous parts sublet to station men by the rod but was all hand work.

Size of the Tile and Depth of Trenches. The size of the tile required varied from 4-inch to 22-inch with a general average slightly under 6-inch; the depth of trenches was, for the most part, 4 feet or less, but the exact averages are not yet worked out.

It is apparent that the data under consideration are widely distributed as to all natural conditions and well scattered over the present agricultural area of the state and that all excessive abnormalities are eliminated. We may therefore consider the average conditions presented fairly typical averages for the agricultural portion of the state. With this idea in mind it will now be interesting to note the general facts shown by the table, as follows:

Type of Averages Used. The *weighted arithmetic average* based on the acreages involved has been used throughout this study and is what is shown in the table and illustrated on the graph. The common arithmetic average would have no real significance owing to the great variation in acreage involved in the different projects.

Percentages the Only Exact Basis of Comparison. Absolute money values widely fluctuating with varying economic conditions through a period such as the last fifteen years furnish no rational basis of comparison over the same period, as between land values and unit costs of improvements per acre. Relative figures, however, expressed as a rate per cent, based on original values and costs, do furnish an exact basis of comparison in such cases. In comparing advantages of drainage over new land purchase, therefore, the items that should receive especial attention are those in the per cent columns in the table and items *s*, *t*, *w*, and *x* in the following printed summary. The *money* values are also given simply to show the sources of the percentages.

Watershed on Farms Concerned

(a) Individual projects 7 to 500 acres.

(b) Total 2326.73 acres.

ACRES WHOLLY RECLAIMED

(c) Individual projects 2½ to 120 acres.

(d) Total 746.50 acres.

(e) Per cent of farm areas reclaimed—individual projects 0.67 to 79.17 percent, frequent examples running from 15 to 25 per cent.

(f) True average 32.08 per cent.

ORIGINAL NORMAL VALUE PER ACRE OF TOTAL FARM

(g) $20 to $175 (basis of valuation estimate or sale based on producing power.)

(h) True average $112.58 (based on total areas in in each project.)

RESULTANT VALUE PER ACRE OF TILLABLE PORTION

(i) $66.67 to $230.26

(j) True average $165.76 (based on areas tillable before drainage and on total original valuation of entire farm.)

COST OF DRAINAGE

(k) Total $55,549.59.

(m) Per acre of watershed on farm $9.97 to $73.30.

(n) True average $23.87 (based on total area affected in this study and total cost of all drainage in these projects.)

(o) Per acre reclaimed $16.26 to $161.04.

(p) True average $74.41 (based on total area reclaimed and total cost of drainage, all charged to reclamation.)

ADVANTAGE OF INVESTMENT IN RECLAMATION OF THE WASTE SPOTS OVER NEW LAND PURCHASE

1. Based on estimated value per acre of portion of watershed on the entire farm taken as it comes, and on cost of drainage per acre reclaimed.

(q) In dollars,—$84.71 to + $99.46.

(r) True average advantage, $38.17.

(s) Expressed as a per cent,—423.55 to + 59.35 per cent.

(t) True average advantage, + 33.90 per cent.

NOTE: The cost of drainage per acre of watershed covered by items (m), (n), (q), (r), (s), and (t), seems not to have any especial significance owing to the varied character of the surface and greatly varying percentage of wet and reclaimed land.

2. Based on resultant value per acre of land tillable before drainage and on cost of drainage per acre reclaimed.

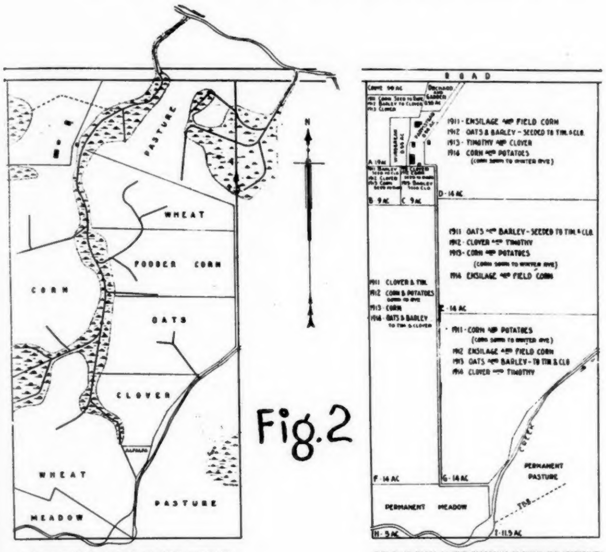


Fig. 2

AN 80 ACRE FARM IN SOUTHERN MINNESOTA SHOWING THE SWAMPY IRREGULAR CONDITION OF THE FIELDS BEFORE DRAINAGE AND THE TILE SYSTEM INSTALLED IN 1909.

THE SAME FARM AS THE FOREGOING SHOWING THE UNIFORMITY OF THE FIELDS AS MADE POSSIBLE BY THE DRAINAGE, IN THE FINAL CROPPING PLAN PERFECTED IN 1914.

A TYPICAL TILE DRAINAGE SYSTEM FOR ROLLING LAND.

NOTE: THE INCOME FROM THIS FARM INCREASED, PRIMARILY AS A RESULT OF DRAINAGE, FROM $994.00 IN 1909 TO $2655.00 IN 1912

COMPARATIVE MAPS OF A FARM IN A ROLLING COUNTRY BEFORE AND AFTER THE INSTALLATION OF A DRAINAGE SYSTEM

A 160 ACRE DOUGLAS COUNTY FARM SHOWING IRREGULAR CONDITION OF FIELDS BEFORE TILE DRAINAGE DUE TO MARSH POCKETS, WATER COURSES AND CAPSTAN DITCHES, AND THE TILE DRAINAGE SYSTEM INSTALLED IN 1911.

Fig. 3

THE SAME FARM AS THE FOREGOING SHOWING THE UNIFORMITY OF FIELDS MADE POSSIBLE BY TILE DRAINAGE IN THE TRANSITION PLAN OF 1912.

(u) In dollars,—\$38.04 to + \$175.74.
(v) True average advantage, \$91.35.
(w) Expressed as a per cent,—57.06 to + 91.53 per per cent.
(x) True average + 55.11 per cent.

POINTS TO BE REMEMBERED IN CONSIDERING THE DATA PRESENTED. Original per acre values used are largely estimated, hence may be subject to question. Where estimated land values may appear very high the expense of drainage was, as a rule, also excessively high due to general economic conditions so that the two sets of prices should still be fairly comparable, although a reference to the chart in Fig. 1 shows a marked divergence in this respect in 1919.

Where cost of drainage is far in excess of even resultant value of land tillable before drainage, the original land before drainage was as a rule nearly valueless but took on great value subsequently as the direct result of drainage. This is especially true of Items 11 and 15, the land in question in the case of Item 11 being a peat bog which before drainage produced only a limited amount of rather low grade wild hay in moderately dry years, and in the case of Item 15 being a wild peat bog which previous to drainage produced nothing but valueless second growth tamarack brush. In the case of Item 8 it will be pertinent to note that this project covered the experimental fields of the North Dakota Agricultural Experiment Station at Fargo and that the relatively high cost of drainage was due in considerable measure to the installation of more lines of tile than would ordinarily have been needed to drain completely the tract in order to lay the tile lines only along the field roads and alleys and thus to avoid cutting up of the experimental plots and disturbing the surface soil which had been under a definite line of treatment for years previously.

GRAPHICAL CORRELATION OF LAND VALUES AND COST OF DRAINAGE. In order to make possible the plotting of a correlation graph of the data discussed in this paper, the several projects of any one year were merged into one set of items for that year and from this new table, omitted here to save room, the chart in Fig. 1 was drawn. Inspection of the correlation graphs in Fig. 1 shows a tolerably consistent relation between the land values and cost of reclamation by drainage for the first half of the period but a decided lack of it during the second half. In explanation of this it is pointed out that in the second half the tendency is toward larger areas and flatter land which called for a much larger relative amount of small tile and shallow trenches with relatively cheaper unit cost for drainage resulting. However, a separation of the graphs for the rolling and flat land, which was done during the study, showed nothing particularly significant.

STRAIGHTENING OF FIELD LINES. Apart from the relatively low cost of reclamation of the waste spots, another very greatly marked advantage resulting from drainage in case of several of the items, is the straightening of field lines by the elimination of impassable wet areas. In the case of Item 3 the entire eighty acres was traversed by a narrow running slough with several irregular branches which was impassable by teams and implements for almost its entire length except during the driest part of the summer. It cut the farm up into twelve extremely irregular fields, varying greatly in size, and mostly difficult of access, whereas drainage enabled a permanent system of nine regular fields to be established and the operation of the farm, without change of ownership, to be raised from a hopeless struggle to a paying business proposition. (See Fig. 2.)

In the case of Item 6 the amount of reclaimed land was very small, the drainage being undertaken largely because of the very apparent benefit it would be to field arrangement and operation. Before it was drained the farm was badly cut up by narrow irregular water course with several branches. This channel was traversed by capstan ditches and was practically impassable in all but a few picked spots except in very dry seasons and so very greatly interfered with uniformity of fields and farm work. The official report reads that in 1911 "the noticeable effect of the drainage system on this farm was the replacement of the old irregular field lines by regular ones and the addition of eight acres within its original boundaries, to the tillable area of the farm." (See Fig. 3.)

Although charts of the new field arrangements are not yet available for items 9, 10, and 12, it can be authoritatively stated that the advantages to field arrangement and operation were quite as noticeable as those of Items 3 and 6.

CONCLUSIONS. The number of projects and the total area involved, although covering a long period of time, does not justify the drawing of any hard and fast conclusions, but in summing up the following tendencies may be noted:

1. The average Minnesota farm, under cultivation before artificial drainage is installed, tends to include areas that are entirely waste, due to lack of drainage, amounting to upwards of one-fourth of their entire area.

2. The tendency of this condition is to raise the normal value per acre of the portion tillable before artificial drainage to an abnormal figure, nearly 50 per cent above the general flat valuation before drainage.

3. Drainage of the waste spots, which will generally bring under cultivation all the land within the present limits of the farm, can frequently be done at a cost per acre not greater than two-thirds of the flat value per acre of the undrained farm and therefore considerably less than one-half the resultant value per acre of the originally tillable land.

Wisconsin Drainage Studies

TO ASCERTAIN the quality of drainage which has resulted from the outlet ditches already installed, studies have been made by E. R. Jones and O. R. Zeasman of the department of agricultural engineering, University of Wisconsin, in the Portage County, Clark County, Dancy, Little Yellow, Cutler, and Remington Drainage Districts. The work was done in cooperation with the U. S. Bureau of Drainage Investigations.

The depth and condition of the ditches, the height of the water table in the soil between the ditches and the general availability of these lands for settlement on the basis of drainage, were investigated because these data are of special value to the prospective owner before he locates on lands of this district. In the Portage County District there is ample drainage between ditches a mile apart where peat about two feet deep lies on sand, and the top of the water in the ditch is four feet below the top of the sand. During the drouth of 1921 timothy and alsike suffered somewhat except where the water was held up during June and July by a dam in a ditch carrying considerable water. Excellent crops of corn and sugar beets resulted without subirrigation, particularly on the deeper beds of peat that are more drouth resistant. On the clay-bottom lands of the Cutler project tile will be needed to complete the drainage.

Settlers are making a success on 80-acre farms in these districts by cultivating for the first year or two only such portions as have good drainage during the early spring, and pasturing the rest until they are able to drain and fertilize properly. Peat lands should be rolled with a heavy roller after seeding. Timothy and alsike require less drainage than corn and are profitable crops on marsh lands (if properly handled) whose drainage is only fair, thus providing a hay crop for the marsh farmer's stock during the first year or two or producing a cash return if sold.—From annual report of the Wisconsin Agricultural Experiment Station.

How Field Experience Should Influence The Design of Farm Machines*

By **G. B. Gunlogson**

Mem. A.S.A.E. Research Engineer, J. I. Case Threshing Machine Co.

FIELD performance is the fundamental test of any farm machine and is the basic factor in its evolution. The importance of this factor in its influence on design and improvements in a machine is too well recognized to emphasize here; rather it is the purpose of this paper to point out the possibilities of reducing this factor to more definite and scientific quantities and to suggest how it may influence in a greater degree the design and development of farm machines.

The design of a new machine involves:

1. Solution as a whole of the requirements and work problems involved.

2. Design of a mechanism to function as required.

3. Selection of materials and proportioning of parts so that they will withstand the stresses of loads and motions.

In designing the machine, the engineer must to a large extent rely upon established knowledge of related machines together with his judgment and considerations for various practical aspects. Engineering theory must be compromised with so many uncertain factors of requirements that the problem of the designer becomes a very complicated one.

It is evident that the merit of the machine will largely depend upon the soundness of the basic information and data available and the judgment exercised in evaluating and using this knowledge. To demonstrate and test the practical operation of the completed machine, various tests and trials are prescribed designed to indicate or measure its performance and capacity and to bring out any structural weaknesses. This stage of development may extend over a long period of time and the work carried on under a variety of conditions to stimulate and approach as nearly as possible, actual operations to be met with in the farmer's hands.

Everything is done to effect the highest possible degree of perfection in the machine before placing it into production, in full appreciation of what it means in a business way to place a machine on the market that is likely to give trouble and also of the cost involved in having to make changes later in patterns and production devices. When the stage is reached that the machine is put into commercial production, it is supposed to have been developed to the highest degree of perfection reasonably attainable.

But with all the ingenuity and effort of the best and most exacting engineering department, with the further aid of the most exhaustive tests and trials, no machine can be fully developed before it is placed on the market and in use.

When a machine is put into general use, some shortcomings and weaknesses develop which before are impossible to discover or foresee. In many cases unfortunately less effort is made to develop and improve the machine when this stage is reached. This is not due to lack of desire on the part of the maker to improve his product, but is due to lack of definite knowledge of its performance in the field.

The average engineering department has in its possession a fund of general engineering information, but often lacks the specific knowledge and records of actual machine performance to carry on development with sufficient exactness to attain a high degree of perfection. It requires very definite and very specific knowledge to proceed with improvements beyond a certain limit. The closer we approach the ultimate, the more definite and more specific must our knowledge be.

It is yet not fully appreciated what a wonderful field for study of farm machinery design is offered in the vast laboratory of our six million farms. With sometimes thousands of machines of a single type and design working daily under all conceivable conditions, the manufacturer has a splendid opportunity for making accurate study of performance and construction. The problems here are to develop the contact or means to procure exact data and to reduce that into definite quantities and factors. The essential requirements to accurate and scientific results are that the data be based on the largest possible number of machines and that it be confined to specific reports on individual machines.

The only contact between the average manufacturer and his product is through service and it is through this relation or contact that this source of engineering knowledge must be developed. There are two essential phases to any work along this line. The first has to do with the source and the method of collecting the data and the other the analysis and application. There are four quite definite channels, with some modifications, by which this information may be obtained by the manufacturer:

1. By reports on special forms by service men of service work done on machinery.

2. By reports on machine or conditions of machines by field man, dealer or owner. (This is a more indirect contact.)

3. Parts returned as defective for credit.

4. All repair parts used.

Perhaps I can give you a little better idea of this work by outlining briefly some effort along this line made by the company with which I am connected. A complete record of service work is maintained, made up from reports of service men. Every effort is made to get the men to furnish definite and specific reports on each machine and each time any work is performed, on forms designed with this requirement in view. These reports are carefully classified and tabulated as they come in. This record is then gone over, analyzed and summarized monthly.

The accompanying table is taken from this record and merely shows the monthly variation in the relative magnitude of the troubles covered. The machine in question is a tractor brought out by the company late in 1918 and the figures are for 1919 operations. It will be noticed that some pulley bearing trouble was developed the latter part of the summer. Immediate steps were taken to remedy this, although the effects do not begin to show up until the following year.

A great deal of trouble was had with the governor at the start. There was no time lost in finding the cause and with a small change in design the trouble was overcome. An instruction bulletin was sent into the field, explaining to dealers and owners how this could be remedied there; so by the end of the season that trouble was entirely taken care of. A

*Sixteenth annual meeting paper.

TABLE OF TROUBLE PERCENTAGES BASED ON TOTAL COMPLAINTS REPORTED MONTHLY—(1919)
TOTAL REPORTED—1743.

Part or Trouble	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Clutch	8	16	17	13⅓	8	10	13	6⅓	5⅔
Pulley bearing	2	0	¼	⅔	2⅓	1⅓	5	11⅔	15
Differential	0	⅔	1⅓	1⅓	3	13	·18⅓	17	15
Bull Pinion	3⅓	5⅓	8	7⅓	4⅔	2	1	⅔	0
Wheels	0	2⅔	5	4	2⅓	2⅔	3⅔	6⅓	0
Governor	22⅔	24	19	22	20	15	8⅔	9	5
Fan	6⅓	11	13	6	6	3	3⅓	2	2⅔
Overheating	4	5	4	5	18	17	12⅔	7⅔	10

similar experience was had with the fan drive and the table shows the story in this case.

This table serves to:

1. Show the relative seriousness of defects and weaknesses of the machine.

2. Visualize the progress being made in remedying those weaknesses.

3. Suggest timely and remedial instructions for dissemination among owners and dealers.

4. Show seasonal and conditional changes in performance.

It is apparent that the basis of these charts is general and is only a preliminary step to the special analysis that must be made of each kind of trouble to determine the particular part at fault and the nature and cause.

There are a few points in connection with this brief outline that should be made at this time. The subject has been approached from the standpoint of its influence on design and betterment of the product. Nothing has been said about the service phase or the possibilities of improving this very important work by scientific analysis of field conditions.

There is nothing new about service reports and reports of all kinds on machinery in the field. I suppose every manufacturer employing service men or salesmen get such reports, but there is probably nothing more misleading than a mass of general complaints and reports from the field on the condition of machinery because of the wide scope usually assumed and the indefinite character of the information. Very often in such reports conditions are exaggerated; broad statements are made which mean nothing, and an indefinite number of units or machines is often covered which makes it impossible properly to classify or evaluate the information. When this material is divided among three or four departments, it may serve to interest temporarily a few individuals but can have little constructive effect upon design or improvement of service.

A less direct source for field data is through the dealer selling the machine or the owner. There are ways for developing this contact at practically no cost, to an extent of yielding a vast fund of information. This may bring out many minor weaknesses and especially discrepancies in design that are not easily detected through other channels. A man is mostly concerned with his gravest troubles, so when our contact is limited the serious troubles may keep from us many less serious ones. Through this channel it is possible to extend our source of information almost indefinitely. Here again it is important that the information be specific and apply to individual machines. The proper system and forms are essential to any satisfactory results in this work.

The possibilities of this third channel of information is perhaps more apparent than of the others. Every part replaced gratis is admittedly inferior or defective in design, material or workmanship.

The fourth source of information is based on the breakage and wear of machine parts. A record of repair parts sold furnishes a wonderful guide for constructive design and improvement in quality of manufacture. A replacement factor can be established for every part in the machine by the simple mathematical expression:

$$\frac{\text{Number of parts used}}{\text{Number of machines}} = \text{Replacement factor}$$

There are of course many modifications that may be made to better adapt this formula. When this is worked out for a whole machine it tells a very interesting story. This factor represents the ultimate index of endurance for every component part in the machine, which should be an invaluable guide to improvement. A further development would lead us to the determination of certain standards or tolerances to check against. Beside its engineering value this factor forms a ready basis for determining the quantity of repair parts needed for any number of machines, since the number of machines multiplied by this factor expresses that quantity.

I dare say many of you have had experiences with machines whose dependability has been constantly at stake because of frequent breakages and wearing out of few simple parts. I also believe many of you have been impressed with another fact: When the average machine is given up and delivered to the junk pile, it is not all broken up or worn out, probably three-fourths of the parts are still good for many years of service.

By making better use of records of field experience, I believe it is possible to improve the average farm machine, increase its dependability and greatly lengthen its useful life, with a negligible increase in cost.

This phase of engineering has been slow in development. The most conspicuous example of results obtained from scientific study of performance to my knowledge is that of the London General Omnibus Company in England.

Their plan was put into operation some years before the war. About twelve years ago this company had some 2,000 buses in use, of the best French, German and English makes. At that time the company had no great experience in handling a large fleet of trucks and its service facilities were not fully organized, with the result that at the end of the year one-half the vehicles were out of commission at a time. Steps were then taken to improve these conditions. Better service facilities were provided, and a system of checking service work and requirements was inaugurated.

A thorough engineering department was established, and a comprehensive study of service and performance records was undertaken. This lead to another special study of the most efficient make of truck as established by the preliminary records.

Some years later the company brought out its own truck. The design was based almost entirely on this data obtained from actual experience. With this new truck the number of machines out of use was reduced to ten per cent.

The system was further intensified. More exact and more specific data on each individual part in every machine was needed to carry on development to a still higher degree. The result was that at the end of another year less than 2 per cent of the buses were out of commission, a reduction of fifty per cent to less than two per cent.

In conclusion I want to reiterate that the ultimate test of any machine is its actual use during the entire period of its useful state and the result of this test is the final basis for design. There can be little progress or improvement in design until our knowledge of actual performance and requirements of machines becomes more complete and more specific. The problem of the farm machinery designer today is not so much a matter of meeting requirements as it is to know what requirements to meet, and a scientific record of field experience presents these requirements.

Building the Modern Farm Home*

By K. J. T. Ekblaw

Mem. A.S.A.E. Agricultural Engineer, Portland Cement Association

IT IS with no excuse whatever that I bring again before the Society the matter of the modern rural home. Adequate rural housing is an essential in the development of the best type of agriculture. Rural housing has several aspects including, among others, the economical, the sociological and the construction. While we as agricultural engineers are most directly interested in the construction phase of the proposition, yet as engineers and citizens we cannot ignore the other phases.

The fundamentals of existence are of course always practically the same—food, warmth, shelter, protection. In primitive times a tree, a cave or even less, if you can imagine, constituted the home; the food supply was very low in quality and intermittent, often scanty; and undoubtedly our ancestors suffered from inclement weather even as wild animals do today. However, modern improvement and progress have brought about methods of living wonderfully different today from what they were in primitive times; as civilization has improved so has the home been made better and home life thereby rendered richer.

The pioneer farmer of this country had in many ways to revert to the primitive. He had to provide shelter, but there were no lumber yards or building materials' dealers from whom he could purchase materials. He had to provide food but there were no groceries or meat shops where he could purchase supplies. He had to provide clothes but there were no haberdashers or dry goods stores to supply them. As a consequence, pioneer methods of living were often far from satisfactory. It is hard for us to realize the sacrifices which were made by the pioneer in order to forge ahead or even gain a livelihood.

It is gratifying to know that among the engineering demands which are coming from agricultural fields, one of the chief ones is for better homes. Wm. A. Etherton expresses this well in his treatise, "The Farmhouse Improved," published by the Kansas engineering experiment station:

"The American farm home is coming to its own. It has suffered neglect during past years of industrial progress and territorial expansion, but there is no longer so great a need as formerly for sacrificing the home 'to get a start.' Moreover, the American farm family knows today, better than ever before, that home improvements are necessary to a realization of the things in life that are most worth while. It knows, too, that the future holds greater opportunities for the farm home and greater incentives for improving it than have obtained in the past."

Significant emphasis is laid in this statement on the necessity for improvement in the farm home and with this idea we are in full accord. We believe that the modern farmer is fully entitled to the best. We believe that the farm residence should not merely supply the basic requirements of food, warmth and shelter, but that the ideas of beauty, efficiency and economy should be included as well.

It is, of course, well understood that it is difficult to enumerate the minimum requirements of a farm home because of the ready possibility of a disagreement as to what might constitute these minima; but it is believed that the list herewith enumerated constitutes a fair conclusion of those requirements which are the most outstanding:

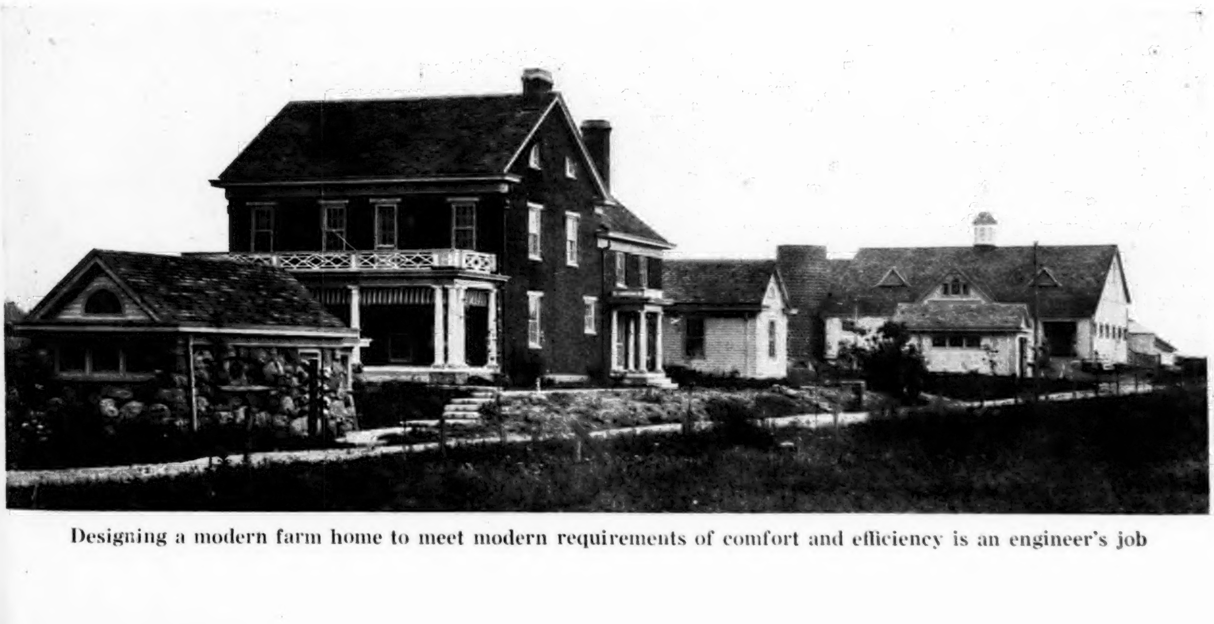
1. A house consistently beautiful and attractive, both inside and out. The principal rooms should have a pleasant outlook, and advantage should be taken of attractive vistas.

2. Materials of construction should be considerably permanent in order that depreciation and the cost of maintenance be kept as low as possible and that the structure be reasonably safe from destruction by fire or storm.

3. Provision for the development of the family and community social life, and for the business administration of the home and farm. This involves an office, which may be used also as a library, and it should be available for the use of both the master and mistress.

4. Provision for dining and for culinary operations, preferably in separate rooms, and for storage of food and equipment either in a pantry or in adequate and convenient cupboards.

*Sixteenth annual meeting paper.



Designing a modern farm home to meet modern requirements of comfort and efficiency is an engineer's job

5. Adequate space set off for sleeping purposes, separate bedrooms being provided for the use of parents, for male children, and for female children. Employes' bedrooms should preferably be located separately from the region of the family sleeping quarters, and if both male and female help are employed, the rooms for each should be completely separated. One of the family bedrooms may well be located on the first floor, to be used in case of illness. A special guest bedroom is worth considering.

6. Every bedroom should have an adequate clothes closet opening from the room.

7. Adequate equipment to lessen labor and to simplify the conduct of household operations. This should include heating, lighting and water supply. A washroom to be used for laundry purpose, temporary fuel supply, and the storage of such things as coats, overalls, boots, tools, etc., is a valuable addition. This room should be placed next to the kitchen and on the direct route between barns and dining room. The function of this room is to act as a sieve between the outdoors and the house, and it should be provided with a concrete floor, with drain, and with laundry tubs.

8. Adequate sanitation, with bathroom including lavatory, bathtub or shower, and water closet. Separate bathing facilities for the farm help are desirable.

9. Adequate provision for light and ventilation, with at least one window in every room that may be opened.

10. Adequate insulation from cold in order that a reasonable degree of warmth may be maintained.

11. Smooth, dry floors.

12. Watertight construction in walls and roof.

13. A light, dry basement in which should be made provision only for storage or for the location of household equipment, such as heating, lighting and water supply systems.

Since it is generally conceded that there is an intimate relationship between an efficient type of farm home and successful agriculture, it is incumbent upon us as engineers to be able to differentiate between good and bad types of construction and to be able to make recommendations to our agricultural clients as to what constitutes proper types of building materials and construction. The first essential of course is that we have a good plan, for often the most important part of building a house is accomplished before actual construction begins. The economy, comfort, convenience and even the appearance of the house are largely dependent upon the care and thought employed in devising the plan. The ability to plan conveniently and well is not possessed by everyone. It is acquired mainly by training and experience. While the home owner may easily differentiate between the plan that is positively good and one that is unquestionably bad, he is often at a loss to judge the indifferent or to suggest improvement. In order to eliminate the haphazard and inefficient plan which is so likely to result when produced by the amateur, I believe that our first recommendation should be the employment of a reputable architect to prepare the plan, or at least insistence upon reference to the plan books issued by reputable commercial concerns who are interested in the promotion of good building and who employ the services of properly qualified architects to prepare such plans. Reduced to commercial terms, the cost of an architect's services is plain economy, for rarely does he serve but what he makes for his employer a direct tangible saving in construction costs, several times greater than the fee he receives.

The next recommendation which we should be prepared to make is in regard to the character of the building material. This field is one in which there is likely to be considerable difference of opinion but we should approach it with the idea of making such recommendations as will truly promote the best interests of the consumer. Availability, flexibility and durability are building materials' qualities that must be thought of, as well as the ability to utilize them so that the result may include both economy and beauty.

There is no doubt that permanent materials are superior to any others, and to recommend any others is not the part of wisdom. Their use is accompanied by little and often no extra expense at the outset, and they are effective in materially reducing the cost of repairs and maintenance of the house, an item of serious import to the average home owner. Well designed houses built of permanent materials become increasingly attractive as the years go by. The wise home builder of today knows that for a very little increase in the cost of his home spent on permanent materials that will not burn, decay, sag, settle, warp, nor require frequent maintenance, is money that will at once begin to earn dividends for him. A home built of permanent materials is always an asset to the community as well as to the owner.

Without going into the intimate details of residence construction, it may be of interest to take up some of the elements and show how permanent building materials can be utilized to produce a structure that is attractive and economical. I shall speak of concrete because of the prominence it is achieving at the present time in the construction world and because the public wonders why more use has not been made of it in residence construction. Its enduring qualities make it seem to be the logical material for residences, but although it is extensively used for larger structures, it has not made so much headway in home building as its merits warrant. This is due perhaps primarily to the lack of interest on the part of the builder or purchaser, and also perhaps to the fact that some concrete houses that have been built are unsatisfactory as a result of lack of care in design or construction, or lack of fundamental knowledge of the principles of home building.

To include a discussion of all the various types of concrete construction would make this paper long and unwieldy so I shall further confine myself to a brief presentation of the use of concrete blocks because of the many particular advantages that this material possesses, especially when utilized for rural work. It is a permanent, flexible, fire-resisting material with a strength very much in excess of that required to carry the building and to maintain it in perfect rigidity. High quality blocks are available in practically every locality, and they are made in such a variety of sizes, shapes, and finish that the builder is not circumscribed by limitations in any direction.

Concrete blocks are a superior foundation material and when properly laid can be made to furnish a very strong, waterproof basement wall. The walls of homes may be built up with them using any one of the special forms of block devised for wall construction. A rigid, permanent, well-insulated wall will result. Light partition walls can also be made of concrete block.

If we are building foundation walls of fire-resisting material, it is only logical to continue its use in other parts of the building. The subject of concrete floors has been much discussed, but I believe that if every skeptic could inspect the children's cottages at Mooseheart, Illinois, and see how perfectly satisfactorily concrete is utilized in the floors of these cottages, the discussion would be immediately closed with the case made entirely in favor of concrete. These floors are beautiful, permanent and sanitary and the caretakers of the cottages are enthusiastic over their utility. The full extension of the idea of fire-resistive construction would include concrete steps and stairs either in monolithic or block form, both of which are sensible and practical, and the use of concrete roofing tile which are now made in a great variety of sizes, shapes and colors so that the aesthetic tastes of any designer may be satisfied.

The employment of concrete in the ways mentioned is thoroughly in accord with modern ideas of rural building construction and the requirements of the modern rural home. When properly used, concrete blocks can be made to produce a dignified, convenient and enduring structure. The fact that concrete blocks of the proper type form the most superior base for the application of stucco is a further advantage since the colorings and surface finishings of stucco are infinite in variety.

Let me leave with you a few definite thoughts in regard to building of the modern rural home:

1. Build well. Our American homes have been, and many of them still are, altogether too flimsy. A home should not be built to last 10 or 20 or 50 years—thousands of Old World homes are 500 years old or more. The depreciation in a well-built home is so small that its maintenance is practically negligible.

2. Build for comfort and convenience. Probably two-thirds of one's time will be spent in the home, and time and care spent in thoughtful planning will be well repaid in pleasant living. A house that is so well planned that its good points are apparent to every housekeeper will not stagnate in the real estate market, no matter how dull the times, should you ever desire to sell it.

3. Make the home fireproof—not only the walls but the roof, the floors and the stairs. Watch the construction of chimneys and fireplace so that they may not be sources of danger. Fire loss is not only loss of original investment, which may be partially covered by insurance, but it often means loss of home, loss of family treasures, and even of life.

4. Watch the details of construction, and do not skimp on them. Good hardware, first-class plumbing, and wiring that fulfills standard legal requirements are distinct advantages. Put good glass into the windows, good wire cloth on the screens. Numerous other details can be enumerated.

5. Respect the reputable builder. If he be chosen wisely, he is worthy of respect. His business is to build a structure that will satisfy. Work with him. Get the benefit of his ideas, and give him an opportunity to cooperate. This is the only way in which there can be any assurance that he will take pride in his work. And give him a chance to make a fair profit—he cannot be expected to work for nothing, nor at a loss.

Helen Binkerd Young says: "Houses stand not for a month nor for a year, but for generations; by them the thrift of a community is judged, by them the ideals and taste of a community are formed. He who deliberately builds an ugly house condemns himself as a poor citizen, while he who builds a beautiful house proves himself a good citizen for his personal effort contributes to the public welfare."

Convenience, beauty, permanence—these three should be the attributes of the modern rural home. Failure to include any one of them is a failure to accomplish the best in design and construction, which the rural home deserves. Let us build our rural homes so that in them we may see reflected the true character of American agriculture—the integrity, and solidity, and permanence of which constitute the Nation's true foundation.

A Man Cannot Afford to Compete with Machinery*

By B. Youngblood

Director, Texas Agricultural Experiment Station

THE more one considers the interdependence of the factors of production—land, labor, and entrepreneurship—the more he will become convinced that in his efforts to secure livelihood, he cannot afford to match his muscular strength against the mechanical power of a machine. The Brazilian farmer, who cultivates his cane, coffee, and cotton with nothing other than a primitive hoe, is in effect competing with the one who does his cultivation with a modern cultivator. Obviously the man with a hoe cannot produce as much with his labor as the man with the cultivator, and the chances are that the latter has a larger income and lives better.

Now the ordinary cultivator, itself, is not all that could be expected of such an instrument. Its traction might be reduced, for example, by the use of dust-proof roller bearings and it might be made more easily adjustable and less inclined to get out of order. The agricultural engineer finds his opportunity for usefulness in just this field. If he is ingenuous he will find opportunity not only to make improvements on the present types of farm machinery, implements, and tools now in use but also to invent new implements which serve new purposes and further reduce the proportion of manual labor required in agricultural production.

Entrepreneurship is that factor of production which conceives of a useful enterprise, provides the necessary capital, and assumes the risk of loss or gain. Now the man who grows up with no other experience than of securing his livelihood by daily wages for his physical or mental labor usually makes nothing more than a living according to a modest if not a meager standard. Moreover he has little or no opportunity for the development of the faculty for entrepreneurship, which is to say he does not develop good business ability. If a man does not develop good business ability, he is not likely ever to accumulate a great deal of capital through saving, and if he has no capital then the chances are that he will have to continue through life, living by his daily mental or physical labor and working in competition with rather than in cooperation with machinery.

If a man develops no reputation for business ability by accumulating and using capital or, what amounts to the same thing, machinery, it is likely that he will have but little opportunity to exert influence for good in the world, no matter how lofty may be his ideals or worthy his motives. There is no getting around the proposition that wealth and reputation for business ability carry proportionate influence in our society whether we like it or not. If a man uses this influence for promoting the physical, mental, moral, and social advancement of his fellow man, we are inclined to applaud, but if he uses it to the disadvantage or degradation of his fellows, we condemn, and all through life, we are constantly having opportunities to exert our energies in the applause of the one and the condemnation of the other. The problem of society is not to reduce a man's influence but rather to increase it and direct it along proper channels.

It happens, therefore, that the best advice which can be given to students is to work, save, and accumulate capital, use it in production, develop the faculty for entrepreneurship, and accumulate such wealth as may be accumulated in our society by proper methods and, if thus he prospers, let him think not only of himself and family but also of his fellows and, in passing through life, accomplish great and good things in the world to the end that our entire civilization may be advanced.

*A talk before the A.S.A.E. Student Branch, Texas A. & M. College, March 5, 1923.

Agricultural Engineering Development

A Review of the Activities and Recent Progress in the Field of Agricultural Engineering Investigation, Experimentation and Research

Edited by **R. W. Trullinger**

Mem. A.S.A.E. Specialist in Rural Engineering, Office of Experiment Stations, U. S. Department of Agriculture

THE FARMER'S SHORT-BOX MEASURING FLUME, C. Rohwer. (*U. S. Department of Agriculture Bull.*, 1110 [1922], pp. 13, figs. 8.)—Studies on a short-box measuring flume conducted under a co-operative agreement between this department and the Colorado experiment station are presented in this report. Tables and charts are presented which are applicable to a standard short-box measuring flume which includes a weir with completely suppressed end contractions and a partially suppressed bottom contraction. No provision is made for the aeration and lateral expansion of the nappe, as required in the standard weir without end contractions. The floor of the weir box is level and is placed at the grade of the ditch in which it is installed. The weir bulkhead is variable in height, depending on the conditions it has to fulfil, and it is usually made from the commercial sizes of 2-inch lumber. No attempt is made to keep a sharp edge at the crest. The bulkhead is not fixed but may be removed by sliding it out of grooves in the walls of the weir box for the purpose of cleaning.

Formulas for free and submerged flow for this measuring flume were deduced from the data obtained. These are empirical formulas based on the calibration of 1, 2, 3, and 4-foot flumes with 4, 8, 12, and 16-inch weirs for various heads and differences of head.

A comparison of the experimental discharges with the computed discharges for the free flow and for the submerged conditions showed that 77 per cent of all the free flow computed discharges were in error by less than 2 per cent, and that 74 per cent of all the submerged flow computed discharges were in error by less than 5 per cent. The results showed that the submerged condition should be avoided if possible. For free flow conditions it was found that the gauge height may be measured either on the crest of the weir or one foot upstream from it. For submerged conditions both the upstream and the downstream heads must be measured. Changes such as might occur in the flumes in the field do not affect the discharge sufficiently to impair the usefulness of the device. The accuracy of the device is considered to be sufficient for ordinary requirements, but it is not recommended in preference to the standard types of weirs.

DUTY OF WATER INVESTIGATIONS ON COAL CREEK, Utah, A. Fife (*Utah Station Bull.*, 181 [1922] pp. 3-22, figs. 11.)—The results of five years irrigation investigations on the net duty of water under Coal Creek, Iron County, Utah, conducted under a cooperative agreement between the United States Department of Agriculture and the Utah station, are reported. The primary purpose of this investigation was to establish a scientific basis for the distribution of water to the various users.

Increasing the use of water to a depth of 70 inches for alfalfa on land having primary water rights increased the yields. Under secondary rights the capacity of the soil to hold moisture for late crop growth was found to be the most important single factor in the determination of an economical use of water. The net duty of water for grain ranged from 20 to 40 inches. Where uniform lateral distribution of water was difficult to obtain the requirement was high. Little more than 24 inches of water was necessary for potatoes.

It is concluded that improvements in land preparation and in methods of irrigation to obtain a uniform lateral distribution of water offered the greatest opportunity for increasing efficiency in the use of water. An immediate limitation of water applications to the amounts shown by the experiments to be necessary is considered neither desirable nor feasible. The adoption of a water distribution policy that will reward skilful and intelligent users and will penalize those using careless methods is recommended as a proper procedure pending the attainment of the ultimate goal of having the water used on a truly economical basis.

GROWING IRRIGATED CROPS IN HARNEY VALLEY, OREGON, O. Shattuck and D. W. Ritchie, (*Oregon Station Bull.*, 191 [1922], pp. 3-24, figs. 15.)—The results of investigations conducted on the soils in the Harney Valley of Oregon to determine the crop adaptations, water requirements, proper crop rotations, fertility requirements, and the possibilities of irrigation by pumping are summarized in practical form. Deductions are presented for practical use by irrigation farmers. The border system of irrigation is considered to be one of the best, while the check system is not recommended for Harney Valley conditions. The corrugation system is said to be well suited to land sloping in different planes, and the furrow system is well adapted to the irrigation of row crops. Sub-irrigation can be used to advantage on grain and alfalfa where soil conditions permit. Flooding has been found to be a wasteful method of irrigation.

THE VENTILATION OF POTATO WAREHOUSES, F. E. Fogle. (*Michigan Station Quarterly Bull.*, 5 [1922], No. 1, pp. 20-25, figs. 6.)—Practical information on the ventilation of potato warehouses with particular reference to conditions in Michigan is presented. Successful storage is said to depend on the maintenance of a dry atmosphere and a low temperature in the storage house. A temperature of from 33 to 38 degrees Fahrenheit is considered to be desirable. There should be a movement of air through as well as around the potato piles. To accomplish this it is recommended that the potato bins be not wider than eight feet nor deeper than ten feet. The bins should be kept some distance from the outside walls. It is stated that both the King and Rutherford ventilating systems have been adapted successfully to potato storage houses in Michigan.

CATTLE FEEDING BARNS AND SHELTERS, W. A. Foster and R. S. Stephenson. (*Iowa Station Circular* 74 [1922], pp. 3-23, pls. 2, figs. 25.)—This circular describes cattle feeding barns and shelters which have been used for some time by successful breeders and feeders in the State of Iowa. Diagrammatic illustrations and detailed drawings are included.

CLEARING CUT-OVER LANDS IN BALDWIN COUNTY, ALABAMA. E. C. Easter and M. L. Nichols. *(Alabama College Station Circular,* 45 [1922], pp. 4)—This is a brief report of progress on land clearing and wood distillation investigations in Baldwin County, Alabama. The blasting and combination of pulling and blasting methods of land clearing were compared. The advantages and disadvantages of the two methods are listed. The blasting method requires less initial investment and can be used more economically in removing scattered stumps. Its operation is expensive and the results are less efficient. The combination method has the advantages of cheaper operation and more efficient results. The initial cost is greater, which becomes a greater disadvantage where only a few stumps are to be removed.

A NEW LINE SPREADER, H. H. Musselman. *(Michigan Station Quarterly Bull.,* 5 [1922], No. 1, pp. 26-30, figs. 4.)—A simple wagon attachment for lime spreading is described and diagrammatically illustrated, which it is stated can easily be made on any farm. A bill of materials is included. The spreader is designed to be attached to the rear end of the wagon box and operated by a rocker arm dropping from peg to peg on a disk attached to and turning with the rear wheels of the wagon. The rocker arm moves a board under the hopper which serves as an agitator. The jarring action of the rocker arm upon the agitator and box serve to feed down the line. The machine was successfully tested with pulverized limestone, both dry and damp.

THE FARM SEPTIC TANK, J. C. Wooley, W. M. Gibbs, and R. B. Gray. *(Idaho Station (Moscow) Bull.,* 128 [1922], pp. 3-18, figs. 12.)—The purpose of this bulletin is to describe in a general way the bacterial action of a septic tank and to give in detail the method of its construction and operation. In a discussion of the changes taking place in the materials which enter a septic tank, it is stated that "all these materials driven into the septic tank are easily cared for by the bacteria and changed to simple harmless materials. They enter as a dirty, greasy mixture and leave in a simple and sanitary form. The tank may be placed as near the house as desired because there is no odor from it. The outflowing stream, or effluent, may be run into an open field because it contains only completely decomposed substances and is not insanitary."

SEPTIC TANKS FOR SEWAGE DISPOSAL, E. G. Welch and J. B. Kelley *(Kentucky Agricultural College Extension Circular,* 131 [1922], pp. 3-19, figs. 10.)—Practical information on the planning and construction of septic tanks for sewage disposal, with particular reference to conditions in Kentucky, are presented in this report. It has been found that under conditions in Kentucky the tank should hold at least 24 hours flow of sewage, and in a two-chamber tank the siphon chamber should hold from one-third to one-half of the flow of sewage in 24 hours.

In the construction of disposal beds the tile should be placed at a depth of about 12 inches. It has been found that for the average Kentucky soil 40 feet of four-inch drain tile will be required in the disposal bed for each person using the system. If the soil is quite porous or sandy thirty feet of tile per person will be sufficient. The distance between parallel lines of tile in the disposal bed should be not less than ten feet, and the length should be between sixty and one hundred feet. The disposal lines should have a fall of from 1.5 to 2.5 inches per hundred feet, the former being for a clay soil and the latter for a soil which absorbs water readily. It has been found that the liquid as it leaves the septic tank has not been purified sufficiently and should not be permitted to seep the soil near a well or other water supply.

STUDIES OF FLOW THROUGH CLEARED AND UNCLEARED FLOODWAYS, C. E. Ramser. *(Engineering News-Record,* 89 [1922] No. 15, pp. 598, 599, figs. 2.)—Investigations conducted by the United States Department of Agriculture in the Little River drainage district, south of Cape Girardeau, Missouri, in which mid-course gaugings by means of a current meter were made in cleared and uncleared floodways for the purpose of determining the value of n in Kutter's formula, are reported.

Experiments were conducted on a straight section of a floodway about 2.5 miles in length. Two courses of 3000 feet each were selected along this straight section, one of which was cleared of all growth and obstructions except stumps for 500 feet above and below the ends of the course, and the other was left uncleared below the lower end of the course and for 500 feet above the upper end. The dimensions of the main channel in the floodway were, top width 145 feet, bottom width 60 feet, and depth 20 feet.

Gaugings of the flow in the floodway were made at stations midway between the ends of the two courses. Velocity measurements were made with a Gurley-Price current meter from a boat. Four measurements were made on the cleared course for average depths in the floodway, ranging from 4.4 to 5.5 feet, and three measurements on the uncleared course for average depths, ranging from 4.5 to 4.9 feet. The average value of n obtained for the cleared course was 0.0465 and for the uncleared 0.0777. Computations with these figures showed a difference in discharge capacity between the cleared and uncleared floodways of 62.5 per cent.

The following table gives the hydraulic elements and values of n in Kutter's formula as obtained for the cleared and uncleared courses of the floodway, respectively:

THE MEASUREMENT OF WATER, W. G. Steward. *(Idaho Station [Moscow] Bull.,* 127 [1922], pp. 3-32, figs. 19.) —This is a handbook of practical information and working data for ditch riders and water users.

HYDRAULIC ELEMENTS AND VALUES OF n IN KUTTER'S FORMULA FOR CLEARED AND UNCLEARED FLOODWAYS

Date	Mean gauge height	Average depth — ft.	Average surface width — ft.	Discharge — sec. — ft.	Average cross-sectional area — sq. ft.	Wetted perimeter — ft.	Hydraulic Mean depth = r — ft.	Slope = s	$\sqrt{rs}$	Mean velocity = v ft. per sec.	$C = \frac{v}{\sqrt{rs}}$	n
For Cleared Course of Floodway												
4/1/22	337.43	5.2	828.8	4,137	4,322.6	829.8	5.21	.0000843	.0210	.0957	45.6	.047
4/2/22	337.71	5.5	829.7	4,078	4,540.8	830.6	5.47	.0000696	.0195	0.898	46.1	.047
4/3/22	337.18	5.0	828.1	3,141	4,101.0	829.1	4.95	.0000540	.0163	0.766	47.0	.044
4/4/22	336.55	4.4	826.6	2,243	3,579.7	827.6	4.33	.0000506	.0148	0.627	42.4	.048
For Uncleared Course of Floodway												
4/1/22	336.77	4.5	824.9	2,672	3,698.0	825.8	4.48	.0001592	.0267	0.723	27.1	.077
4/2/22	337.14	4.9	826.7	2,631	4,004.2	827.2	4.84	.0001233	.0244	0.657	26.9	.079
4/3/22	336.75	4.5	825.4	1,875	3,682.0	825.9	4.46	.0000798	.0188	0.509	27.1	.077

AN INVESTIGATION OF THE HERSCHEL TYPE OF WEIR, R. H. Morris and A. J. R. Houston. (*Mechanical Engineering* [New York], 44 [1922], No. 10, pp. 651-654, Figs. 8.)—Studies to determine the effect of the degree of smoothness of the crest and slopes, radius for the crest, position at which the upstream measurement is made, increasing or decreasing the velocity of approach, and changing the position of the orifices in the crest on the action of the improved type of weir designed by Herschel for gauging in open channels are reported.

It was found that all these factors affected the discharge to some extent. Friction greatly affected the discharge, causing a variation as great as twelve per cent. The formula for the discharge was affected materially by the size of the pipe forming the crest. Each size of the crest has definite limits between which the discharge varies as a straight-line function. Upstream measurements taken with three gauges were identical below about 3.5 cubic feet per second per foot length of crest. Above that quantity the gauge nearest the crest showed a slight drop, indicating that the upper-surface curve extended at least six feet upstream from the crest.

It was found further that the velocity of approach cannot be corrected for by means of the simple formula $V^2/2g$. The velocity of approach was increased nearly 300 per cent, with a corresponding difference of about seven per cent in the corrected discharge.

It is concluded that when a weir of the Herschel type is constructed properly there is a constant ratio between the quantity of water passing over the weir and the difference in the two observed pressures. "However, so many are the determinant factors and so great is their influence on the discharge formula that a weir of this type, in its present state of development, would probably be valueless unless calibrated by actual tests. It is believed that further extended research may remedy this difficulty. Probably the chief advantage of the new weir lies in the fact that for the same upstream head it discharges about 20 per cent more water than the ordinary type of weir."

DETONATION CHARACTERISTICS OF SOME BLENDED MOTOR FUELS, T. Midgley, Jr., and T. A. Boyd, [Journal Society Automotive Engineers, New York 10(1922), No. 6, pp. 451-456, figs. 5.]

Studies of the detonating tendencies of mixtures of some of the principal materials that are used as components of the blended motor fuels now available commercially are reported, special attention being paid to the effects of admixtures of various percentages of alcohol and alcohol-benzene mixtures for reducing the detonating tendency of paraffin hydrocarbons. The bouncing-pin apparatus was used for making the determinations.

In order that the effects of the blending materials might be measured through as wide a range as practical, they were blended with kerosene for making the majority of the determinations. It was found that the presence of only a small percentage of an aromatic hydrocarbon in a paraffin fuel has but a slight effect towards suppressing detonation. This is in agreement with the previous observation on benzol-gasoline blends that the addition of less than 20 per cent of benzol to a commercial gasoline or a naptha exerts only a small influence toward causing the engine to give smoother operation. When benzol was blended with paraffin fuels in larger percentages its effect increased rapidly as its concentration relative to the paraffin fuel was raised. Toluene on the basis of volume was more effective than benzene for eliminating detonation conditions and xylene was in turn still more effective than toluene for the purpose.

It was observed that the addition of one per cent of xylidine to a fuel that gives incipient detonation in a certain engine made it possible to raise the compression of the engine about ten pounds without any greater detonation being obtained than with the untreated fuel at the original and lower compression. On the volume basis alcohol was considerably more effective than benzol for the suppression of detonation when blended with a paraffin fuel.

The results further indicated that the detonating tendency of a fuel composed of two ingredients is greater than the average of the values representing the detonating tendencies of the two components taken separately.

EFFICIENCY OF VARIOUS KINDS OF VENTILATING DUCTS, C. E. A. Winslow and L. Greenburg, [Public Health Reports (U. S.) Washington, D. C., 37(1922), No. 30, pp. 1829-1839, fig. 1.]

A study of the uniformity of air distribution attained with ventilating ducts of various designs is reported.

It was found that branch ducts gave better results than lateral ports. With either branch ducts or lateral ports, an untapered main duct gave better results than a tapered one. Other conditions being equal, plenum ventilation was more even that exhaust ventilation. The most important factor determined was the use of slanting branch ducts for the exhaust or discharge of air into or from the main duct. Where such lateral branches were provided the shape of the main duct made little difference, as in all the tests made with such branches in operation results were obtained showing an average deviation of less than 5 per cent.

If lateral branch ducts are not provided it is concluded that the design of the main duct becomes of compelling importance. A tapered main duct with lateral ports gave a distribution so markedly uneven as to detract in a serious measure from its efficiency, whereas the lateral port system, though never so good as one which involves the use of branch ducts, may yield results which are fairly satisfactory if the main duct is untapered.

It is stated in conclusion that in order to secure the most even distribution, ventilating systems on either the plenum or exhaust plan should be constructed with slanting branch ducts, and the question whether the main duct should be tapered or untapered should be decided by the relative cost of labor and materials involved. Reasonably good distribution can be economically effected with an untapered duct discharging or exhausting through lateral ports. A tapered duct discharging or exhausting through lateral ports is likely to give rise to serious irregularity in distribution.

Does Deep Tillage Pay?

WHETHER to use deep tilling machines or to practice deep plowing has caused much discussion in previous years. These results have been obtained at the Marshfield branch of the Wisconsin agricultural experiment station, as a result of from five to nine years' tests as reported in the 1920-1921 annual report of the Wisconsin station:

1. Deep plowing and subsoiling have not been found profitable.
2. Corn on a five-year average has given the best yields on spring plowed land followed by ordinary fall plowing to a depth of six to seven inches.
3. Deep tilling has given the lowest yields.
4. With oats, nine-year tests have shown a trifle higher yield on spring plowed than on ordinary fall plowed land; likewise deep tilling gave the lowest yield. In clover and timothy the results are variable.

Colby silt loam is a rather heavy soil, typical of the Marshfield area and is not like the Miami silt loam in the southern part of Wisconsin. At Ashland subsoiling has increased the yield for the barley crop three bushels an acre over fall plowed land or spring plowed land, although with corn, clover, and clover and timothy the yield was not materially increased. Other deep tillage treatments, how-

ever, did not increase the yield and are not recommended, while the extra cost of subsoiling does not pay for itself. Fall plowing to a depth of six inches has shown a better yield in corn while with hay crops of clover and timothy spring plowing seems to have advantage over other methods.

A. S. A. E. and Related Activities

F.A.E.S. Executive Meeting

THE executive board of the American Engineering Council, the executive arm of the Federated American Engineering Societies, held a meeting at the Ohio Mechanics Institute, Cincinnati, March 23 and 24. The matter receiving the greatest amount of attention by the board was the proposed study of cold storage. The board ordered the executive secretary to proceed with the investigation, the funds for the purpose being already available.

Action taken by the board in connection with the monthly bulletin of the F. A. E. S. included carrying the list of member societies of the Federation on the front page of each issue of the bulletin and that no advertising be carried of any character that appears in the publication of any member society. It was also decided that nothing in the nature of engineering advertising would be carried in the bulletin. The entire matter of advertising in the bulletin has been referred to the committee on publicity and publications.

The chairman of the committee on government reorganization as related to engineering matters outlined the attitude toward the proposed reorganization of the executive departments of the federal government, stating that it was the direct outcome of the work of the American engineers to create a department of public works and that the advantages and economies of such a department were so evident that public-spirited citizens felt it could be carried to its logical conclusion and a complete reorganization of all the executive departments be made. As a whole, engineers favor the proposed plan of reorganization of executive departments as it applies to engineering activities, upon which activities they feel themselves competent to pass. While the proposed plan is not in every detail that advocated by the National Public Works Department Association, engineers feel that the scheme is a great step in advance and will advocate it with perhaps certain modifications. This attitude was voted as the sense of the meeting of the executive board.

In a report made by the patents committee to the American Engineering Council, it was recommended that in the event the German-owned American patents which were taken over by the Alien Property Custodian and sold to the Chemical Foundation, Inc., should be decreed to be returned to the Alien Property Custodian, the F. A. E. S. strenuously oppose the disturbing of the licenses which have been granted under such of the said patents as are necessary for the building up of a successful organic chemical industry, or other industry necessary for national defence or the returning of those essential patents in any way to the Germans; this matter is now the subject of a suit by the attorney-general of the federal government to compel the Chemical Foundation to reassign the patents to the Alien Property Custodian. The report of the patents committee was adopted by the executive board.

The subject of registration of engineers was again brought before the board, resulting in a resolution to the effect that the board should continue to collect and keep up to date the record of engineers registration and licensing laws that may be proposed or passed, together with decisions thereunder, for the use of constituent societies of the F. A. E. S. and others, but that it assumes no control over the action of such constituent societies in regard thereto.

The next meeting of the executive board will be held in St. Paul, June 8 and 9.

Alabama Studies Traction Problem

AN IMPORTANT addition to the one hundred and sixty or more farm engineering investigations of the state agricultural experiment stations dealing with problems of land clearing, drainage, irrigation, farm buildings and equipment, farm machinery, farm water supply, sewage disposal and sanitation, materials of construction, and similar subjects, according to reports to the United States Department of Agriculture, is a project recently undertaken by the Alabama experiment station to determine the fundamental factors influencing traction of wheel tractors. More fully stated, the purpose of this project is to determine the lines of maximum, minimum and intermediate resistance in soil, and lines of maximum, minimum, and intermediate impulsive stress from tractor lugs, with a view to making lines of maximum impulsive stress coincident with lines of maximum resistance in soil as a basis for the development of the proper material, shape, size, location, and inclination of lug on tractor wheels to give the minimum permissible slip and the maximum impulsive traction under worst agricultural soil conditions in the State.

New Plan for Financing Industrial Standardization

A NEW plan for financing the industrial standardization work of the United States, which provides for membership dues on the basis of one cent per $1000 of gross receipts, has been formally approved by the Executive Committee of the American Engineering Standards Committee. And twenty of the most influential industrial executives of the country have accepted places on an Advisory Committee which will cooperate with the Ways and Means Committee in the refinancing of the American Engineering Standards Committee.

In submitting the report of the Ways and Means Committee, A. W. Whitney, chairman of that committee and of the A. E. S. C. declared that the economies which should accrue to the industries of America, through standardization, "are to be measured in billions of dollars, not millions."

This report announces a new class of members in the A. E. S. C. to be known as "sustaining members," and provides a special service to sustaining members, including information bulletins on developments in standardization work in this country and in every other country where industrial standardization is in progress.

The American Engineering Standards Committee, which was organized in 1918, has heretofore been financed entirely by dues from the nine technical societies and seventeen national trade associations which with seven departments of the Federal government constitute its present membership. Annual deficits were cleared by contributions from individual corporations.

It is expected that the new plan of financing will provide annual budget of $50,000 for the Committee. As this sum is to be realized from sustaining membership dues amounting to 1/1000 of one per cent of gross receipts, the total of $50,000 would be spread over industries with aggregate gross annual receipts of five billion dollars. For firms which for any reason prefer to subscribe on the basis of capital, rather than gross annual receipts, the recommended basis is one and one-half cents per thousand dollars of aggregate market value of the corporate securities of the firm.

The plan calls for the appointment of an engineer-translater who will provide translations of standards developed in foreign countries for the information service to sustaining members. The new information service will be an elabora-

tion of the work which the A. E. S. C. has been carrying on in a small way, in calling to the attention of cooperating bodies and the technical press, the important developments in standardization work, foreign as well as American.

New Members of the Society

Charles R. Bohanan, State College Station, Raleigh, North Carolina. (Associate.)

Jesse Bernard Bookardt, department of agricultural engineering, North Carolina State College, Raleigh, North Carolina. (Junior.)

John Guy Fisher, ranch superintendent, Southwest Cotton Company, Box 27, Goodyear, Arizona. (Member.)

H. B. Josephson, instructor in agricultural engineering, University of Saskatchewan, Saskatoon, Saskatchewan, Canada. (Associate.)

Application for Transfer of Grade

Mark B. Reilly, field engineer, Hollow Building Tile Association, Builders Exchange Building, Memphis, Tennessee. (From Student Branch to Associate Member.)

Applicants for Membership

The following is a list of applicants for membership received since the publication of the April issue of Agricultural Engineering. Members of the Society are urged to send pertinent information relative to the applicants for the consideration of the Council prior to election.

Charles O. Aspenwall, assistant manager experimental department, International Harvester Company, Chicago, Illinois.

Nils Berglund, agricultural engineering department, Iowa State College, Ames, Iowa.

R. H. Driftmier, department of agricultural engineering, Kansas State Agricultural College, Manhattan, Kansas.

R. H. S. Henderson, service engineer, Advance-Rumely Thresher Company, La Porte, Indiana.

Arthur Huntington, sales engineer, public relations department, Iowa Railway & Light Company, Dows Building, Cedar Rapids, Iowa.

R. B. Johnston, superintendent of experiments, West Pullman Works, International Harvester Company, Chicago Illinois.

Wanted—Correct Addresses of These A. S. A. E. Members

NOTE: Mail is being returned from the addresses given below. These members, or others who know of their whereabouts, are requested to send the Secretary their correct addresses at once. Inasmuch as delivery cannot now be made, Agricultural Engineering will not be mailed until correct addresses are received.

Nelson C. Beem, Carey, Ohio.

X. Caverno, Kewanee, Illinois.

R. D. Chapman, 1336 Woodward Avenue, Detroit, Michigan.

George M. Duncomb, 136 S. Harvey Avenue, Oak Park, Illinois.

J. C. Elliff, Box 115, Little Rock, Arkansas.

H. A. Hatfield, Bank of Hamilton, Toronto, Ontario, Canada.

W. R. Killinger, 108 S. Franklin Avenue, Riverside, Illinois.

H. D. Lewis, Box 146, State College Station, North Carolina.

M. W. McDonald, Charleston, West Virginia.

John T. Montgomery, Bliss, Oklahoma.

Arthur H. Pearsoll, 1350 Rosedale Ave., Chicago, Illinois.

Jose Rivera, Matamoros 23, Mexico City, Mexico.

F. K. Runyan, 187 Peachtree St., Atlanta, Georgia.

George W. Rynders, Box 127, Bradley, Illinois.

Lee Stewart, Spooner, Wisconsin.

J. H. Stowell, 3500 Colfax Avenue, South, Minneapolis, Minnesota.

S. Y. Sweeney, 111 East Campbell Avenue, Roanoke, Virginia.

T. A. Toenjes, 1115 South Street, Waterloo, Iowa.

L. R. Van Volkenberg, Box 642, Fargo, North Dakota.

J. C. Weidrich, c/o Dempsey Hotel, Davenport, Iowa.

George G. Whitfield, Demopolis, Alabama.

A. A. Wolf, Y. M. C. A., Omaha, Nebraska.

EMPLOYMENT SERVICE

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of Agricultural Engineering. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Non-members, as well as members, are privileged to use the "Positions Available" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

The Secretary receives at frequent intervals bulletins from the Engineering Societies' Service Bureau, 29 West 39th Street, New York City, listing the "positions open" as reported by member societies. Copies of these bulletins are sent to the "men available" listed below, as soon as received.

Men Available

MECHANICAL AND ELECTRICAL ENGINEER, graduate of Cornell University and Armour Institute, with nineteen years of practical experience in designing, manufacturing, and marketing gasoline engines, automobiles, motor trucks and tractors, having specialized particularly on internal-combustion motors and their application, prefers mechanical work cooperating with the different manufacturing and sales departments along the lines of sales engineering, or other work into which his qualifications would fit. MA-104

AGRICULTURAL ENGINEER wants position in southwest. Graduate of University of Illinois 1915, five years practical experience on Illinois farm with power equipment, two years in charge of the agricultural engineering department New Mexico College of Agriculture; considerable garage experience and service experience on unit power and light plants. Also one summer in Philadelphia battery service station. MA-106

AGRICULTURAL ENGINEER, graduating from Iowa State College June 10, 1923, would like position with some company or individual engaged in drainage or irrigation work. Five years' practical farm experience. MA-118.

AGRICULTURAL ENGINEER, graduate in mechanical engineering at Michigan Agricultural College, desires position teaching all kinds of farm machinery or automotive work, or with some farm-equipment manufacturer. Will be available April 1, 1922. Has served one year as instructor in tractors and trucks, and one year conducting service schools for a leading tractor manufacturer. Can furnish best of references. MA-110

GRADUATE AGRICULTURAL ENGINEER, now employed by tractor company, wishes position teaching agricultural engineering work. Will be available in summer or to start next fall. MA-115.

AGRICULTURAL ENGINEER, graduating from University of Illinois at end of present semester (available March 1, 1923) would like position in service department or experimental department of company manufacturing tractors or farm machinery. Three years' practical farm experience in West and one year in Illinois. Age 27. Unmarried. MA-116.

DEVELOPMENT AND RESEARCH ENGINEER, technical graduate, inventive ability, practical, experienced in the development, design, manufacture, and distribution of farm machinery. Can carry through from the embryo idea, through development stages, production in manufacturing, and marketing. Age 29. Married. Excellent character. Available immediately. MA-117.

Positions Open

DRAFTSMAN who has had experience in designing and manufacturing threshing machinery with reliable, well-established farm-machinery manufacturer in central Pennsylvania. PO-1.

DRAFTSMAN to assist in designing threshing machinery and gas tractors with well-established manufacturer of farm machinery in the East. PO-2.

STUDENT FELLOWS OR INSTRUCTOR IN DRAINAGE. The department of soils of the Oregon State Agricultural College will be able to use two student fellows, one in pure soils and one in soil irrigation and drainage work, if they can be promptly located, or an instructor in drainage if fellows are now secured. Write W. L. Powers, chief in soils, Corvallis, Oregon. PO-3.

STUDENT FELLOW IN AGRICULTURAL ENGINEERING. There will be an opening beginning September, 1923, for a student fellow in agricultural engineering at the Virginia Polytechnic Institute. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-4.

INSTRUCTOR IN AGRICULTURAL ENGINEERING. The department of agricultural engineering of the Virginia Polytechnic Institute has an opening for an instructor to handle farm surveying, farm buildings, farm concrete, and rural architecture. He will also devote part time to extension work. Write Charles E. Seitz, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Virginia. PO-5.